

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau(43) International Publication Date  
12 September 2003 (12.09.2003)

PCT

(10) International Publication Number  
**WO 03/075369 A1**(51) International Patent Classification<sup>7</sup>: **H01L 51/20**,  
27/00, G02B 5/30

D. [GB/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(21) International Application Number: PCT/IB03/00724

(74) Agent: VAN WERMESKERKEN, Stephanie, C.; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).

(22) International Filing Date: 25 February 2003 (25.02.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data: *do Sep 04*  
02075861.1 6 March 2002 (06.03.2002) EP

(71) Applicant (for all designated States except US): KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).

(72) Inventors; and

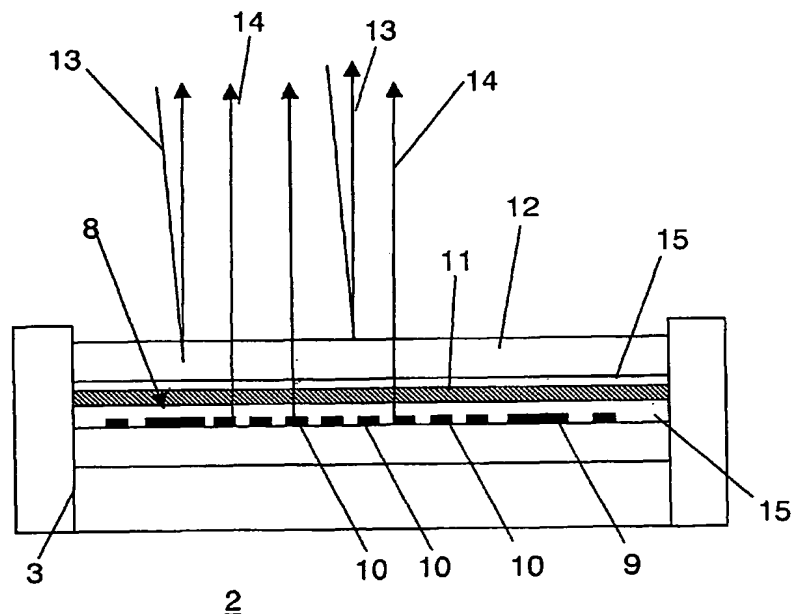
(75) Inventors/Applicants (for US only): BRAAK, Rogier, J. [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). BRON, Marco, J., R. [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). MCLACHLAN, Scott,

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ELECTRONIC DISPLAY DEVICE



(57) Abstract: An electronic display (2) device comprising: a polymer LED display (8); a filter layer (11); a semi-transparent reflective layer (12) covering said filter layer (11) for transmitting light (14) emanating from said polymer LED display and for reflecting ambient light (13) incident on said semi-transparent reflective layer so as to obscure electrical connections for exciting said polymer-LEDs. Due to the reflective properties of the semi-transparent reflective layer (12), graphics of the polymer LED are hidden while the brightness of the display is maintained to a sufficient degree.



**Published:**

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/IB 03/00724

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H01L51/20 H01L27/00 G02B5/30

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L G09F G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, INSPEC

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 99 41788 A (SARNOFF CORP) 19 August 1999 (1999-08-19) page 6, line 3-15 page 13, line 1-25 ----	1
A	US 6 211 613 B1 (MAY PAUL) 3 April 2001 (2001-04-03) claims 1,19,20 ----	1-3
A	US 2001/036013 A1 (CROSS ELISA M ET AL) 1 November 2001 (2001-11-01) page 6, paragraph 68 -page 7, paragraph 77; figures 5A,5B ----- -/-	1,2

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- \*A\* document defining the general state of the art which is not considered to be of particular relevance
- \*E\* earlier document but published on or after the international filing date
- \*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- \*O\* document referring to an oral disclosure, use, exhibition or other means
- \*P\* document published prior to the international filing date but later than the priority date claimed

- \*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- \*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- \*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- \*G\* document member of the same patent family

Date of the actual completion of the international search

9 July 2003

Date of mailing of the international search report

17/07/2003

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax (+31-70) 340-3016

Authorized officer

De Laere, A

## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IB 03/00724

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 053 795 A (ALLEN GREGORY D ET AL) 25 April 2000 (2000-04-25) cited in the application abstract column 9, line 16-34 -----	1,4

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IB 03/00724

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9941788	A	19-08-1999	AU 748146 B2	30-05-2002
			AU 2769099 A	30-08-1999
			AU 757997 B2	13-03-2003
			AU 2769599 A	30-08-1999
			AU 3296999 A	30-08-1999
			CN 1291353 T	11-04-2001
			CN 1291354 T	11-04-2001
			CN 1291351 T	11-04-2001
			EP 1057219 A1	06-12-2000
			EP 1057216 A1	06-12-2000
			EP 1057220 A2	06-12-2000
			JP 2002503832 T	05-02-2002
			JP 2002503836 T	05-02-2002
			WO 9941732 A2	19-08-1999
			WO 9941788 A1	19-08-1999
			WO 9941787 A1	19-08-1999
			US 6370019 B1	09-04-2002
			US 2002050958 A1	02-05-2002
			US 6498592 B1	24-12-2002
US 6211613	B1	03-04-2001	WO 9738452 A1	16-10-1997
			GB 2316228 A , B	18-02-1998
US 2001036013	A1	01-11-2001	US 6515785 B1	04-02-2003
			AU 5324899 A	10-11-2000
			CA 2367749 A1	02-11-2000
			CN 1352751 T	05-06-2002
			EP 1173783 A1	23-01-2002
			JP 2002543448 T	17-12-2002
			TW 444139 B	01-07-2001
			WO 0065385 A1	02-11-2000
US 6053795	A	25-04-2000	NONE	

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
12 September 2003 (12.09.2003)

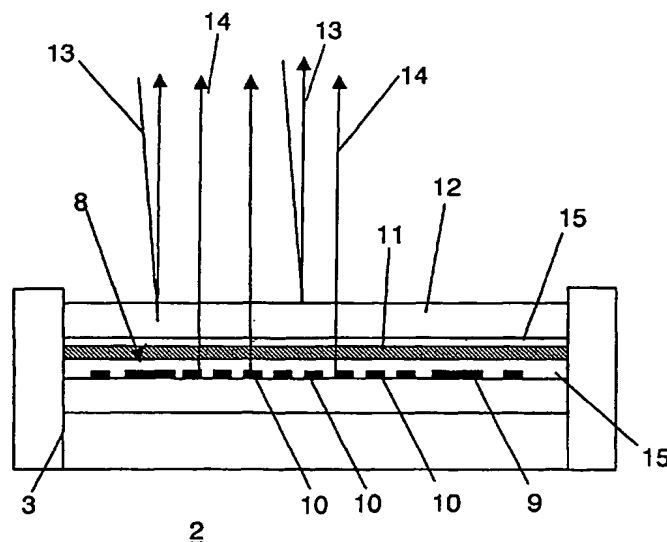
PCT

(10) International Publication Number  
**WO 03/075369 A1**

- (51) International Patent Classification<sup>7</sup>: **H01L 51/20**,  
27/00, G02B 5/30
- (21) International Application Number: **PCT/IB03/00724**
- (22) International Filing Date: 25 February 2003 (25.02.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
02075861.1 6 March 2002 (06.03.2002) EP
- (71) Applicant (for all designated States except US): **KONINKLIJKE PHILIPS ELECTRONICS N.V.** [NL/NL];  
Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **BRAAK, Rogier, J.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **BRON, Marco, J., R.** [NL/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). **MCLACHLAN, Scott,**
- D. [GB/NL]; c/o Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
- (74) Agent: **VAN WERMESKERKEN, Stephanie, C.**; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: ELECTRONIC DISPLAY DEVICE



(57) Abstract: An electronic display (2) device comprising: a polymer LED display (8); a filter layer (11); a semi-transparent reflective layer (12) covering said filter layer (11) for transmitting light (14) emanating from said polymer LED display and for reflecting ambient light (13) incident on said semi-transparent reflective layer so as to obscure electrical connections for exciting said polymer-LEDs. Due to the reflective properties of the semi-transparent reflective layer (12), graphics of the polymer LED are hidden while the brightness of the display is maintained to a sufficient degree.

WO 03/075369 A1



**Published:**

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

## ELECTRONIC DISPLAY DEVICE

The invention relates to an electronic display device comprising: a polymer LED display comprising a geometrical arrangement of individually excitable polymer LEDs for forming an image, and comprising electrical connections for exciting said polymer LEDs; and a light-absorbing filter layer covering said display.

5 Recently, progress has been made in manufacturing this type of display device, which offers a cost-effective substitute for traditional display devices, such as LCD screens or other types of screens. These polymer LED displays exhibit a two-dimensional structure of LEDs which are electronically controlled by electrodes that are configured to connect to the pixel positions. The electrodes and peripheral electronic connections form a  
10 visible structure in said display that is distracting for a person reading out said display. Therefore, a need exists to conceal said visible structure, while at the same time maintaining a sufficient brightness of the polymer LED display when in use.

In the art, filter layers have been applied with filtering properties sufficient to hide the underlying graphics of the polymer LED display and with transmitting properties for  
15 transmitting a sufficient amount of light from the polymer LEDs, in order to achieve a brightness of the display.

However, no sufficient concealment was reached without undue attenuation of light emanating from the polymer LED display. Besides, when filter layers with insufficient absorbing properties were applied, the graphics remained discernible. Therefore, due to a  
20 relatively strong light absorption in the intermediate filtering layer, the known polymer LED display has quite weak brightness properties, and a desire exists to improve the readability properties of current polymer LED displays.

The above-mentioned object is solved by a display device according to the characteristics of the preamble, wherein a semi-transparent reflective layer covers said filter  
25 layer for transmitting light emanating from said polymer LED display and for reflecting ambient light incident on said semi-transparent reflective layer, so as to obscure said electrical connections for exciting said polymer LEDs. When in use, the reflective layer is in a transmissive mode, while, when not in use, the color filter provides a dark background, thus enhancing the reflective properties of the layer. Due to the reflective properties of the semi-



transparent reflective layer, the graphics of the polymer LED are hidden while the brightness of the display is maintained at a sufficient level.

In a further embodiment, the said semi-transparent reflective layer is a reflective polarizing layer. In this embodiment, the losses in the reflective layer due to light absorption are kept optimally low. Such a polarizing layer is known per se from, for example, 5 US-patent No. 6,053,795.

In a further advantageous embodiment, said polymer LED display device, said color filter, and/or said semi-transparent reflective layer are coupled via an anti-reflective coating. Such coatings generate a higher light yield by optimizing the transmission of light 10 between the consecutive layers.

In practical experiments, especially good results were achieved when a brightness-enhancing layer manufactured by 3M Company of St. Paul, Minnesota under the trade designation "DUAL BRIGHTNESS ENHANCEMENT FILM" was provided as a semi-transparent reflective layer.

15 It is noted that this layer, referred to as 3M-DBEF film below, is a light enhancement layer which is typically used in connection with a LCD-layer in an LCD-screen. In such LCD-screens, the LCD-layer is often illuminated by an electroluminescent light source emitting generally unpolarized light and situated at the back of the LCD-layer. The 3M-DBEF layer is a reflective polarizing layer, which reflects the light of the undesired 20 polarization state back into an electroluminescent light source. The electroluminescent light source provides a recycling effect, wherein the light reflected back from the DBEF layer into the electro-luminescent source is returned as light of a generally unpolarized state. This light is again incident on the polarizing 3M-DBEF, thereby increasing the fraction of transmitted light having a correct polarization state. In the electronic display device according to the 25 invention, the reflection of ambient light by this 3M-DBEF layer is quite different from the normal use of this film material, when light emitted by a back-light is reflected by the 3M-DBEF layer. Furthermore, from US-patent No. 6,053,795 discloses a configuration with an electro-luminescent light covered by a color filter and a reflective polarizer such as the above-mentioned 3M-DBEF layer. However, this disclosure is not concerned with polymer 30 LED displays. Furthermore, the disclosure describes the use of twofold layers of polarizing filters, wherein a reflective mode is achieved when the two polarizing layers have a predetermined orientation towards each other.

Further advantages and features will become apparent when reading the description in connection with the drawings, In the drawings:

Fig. 1 is a perspective view of an electronic device comprising the display according to the invention.

5 Fig. 2 is a diagram of a polymer LED display according the invention, having a semi-transparent reflective layer.

Fig. 3 is a Table with test results of two embodiments of the invention.

10 Fig 1 shows an electronic shaver 1 equipped with the display device 2 of the invention. The shaver is a hand-held appliance comprising a synthetic housing 3 accommodating three razor heads 4. In the housing 3, an opening 5 is provided in which the display device 2 is watertightly sealed. The shaver is further provided with a control switch 6 located behind a flexible panel 7 for turning the shaver on or off. In the off-states, the display  
15 device 2 is visually seamlessly integrated in the wall of the appliance 1, in the on-states, the display device 2 can be read out in order to identify a battery status and/or current working status of the appliance 1. As a non-limitative example, the display-device may be contained in other, preferably hand-held appliances, such as mobile phones, gaming devices, etc.

In Fig. 2, a schematic arrangement is shown of the electronic display device 2  
20 according to the invention. The display device 2 has a housing 3 comprising a polymer LED display 8. On the polymer LED display 8, functional information may be indicated in the form of graphics/text etc., such as a battery status, time, etc.

In the housing 3 (not shown), various electronic components are comprised for control and power supply of the polymer LED display 8. The polymer LED display  
25 comprises electronic connections, such as electrodes 9, connecting the individually excitable polymer LEDs 10, which form a geometrical configuration on the polymer LED display 8. In order to conceal these electronic connections 9, the polymer LED display 2 according to the invention further comprises a light-absorbing filter layer 11 covering said polymer LED display 8, for filtering a selected range of light emanating from said display. Said filter layer  
30 11 provides a relatively dark, light-absorbing background which, in combination with a semi-transparent reflective layer 12 covering said filter layer 11, forms a reflective mirror which impairs a view of the interior of the display device 2. When not in use, the display device 2 will look like a mirror, reflecting ambient light 13 that is incident on said semi-transparent reflective layer 12.

When the polymer LED display 8 is in use, i.e. when an image is formed on the display 8, the semi-transparent reflective layer 12 will transmit light 14 emanating from said polymer LED display 8.

5 For reduction of losses, preferably, the semi-transparent layer 12 is a reflective polarizing layer, reflecting light polarized in a first direction and transmitting light polarized in a second direction oriented substantially orthogonal to said first direction. Further, preferably, said polymer LED film device 8, said color filter 11, and/or said semi-transparent reflective layer 12 are coupled via an anti-reflective coating 15.

10 In Fig. 3, test results are given for the reflective and transmissive properties of two embodiments of the invention. Four tests were performed.

In a first test, the transmissive properties of a semi-transparent layer were tested, wherein the layer consisted of a thin metal film deposited on a transparent substrate. This transmission was tested by measuring the light output of the polymer LED in the presence and absence of semi-transparent reflected layer 12. The transmission of the first  
15 embodiment of the electronic layer is 47 %.

Then, the transmissive properties were tested in a second test, where the semi-transparent layer used was a brightness-enhancing layer manufactured by 3M Company of St. Paul, Minnesota under the trade designation "DUAL BRIGHTNESS ENHANCEMENT FILM". Surprisingly good results were obtained with this special film, the transmission in  
20 this second embodiment was found to be significantly higher, up to 59%.

Likewise, the reflective properties of the display device 2 were tested, comparing the results of the first embodiment and the second embodiment. Again, the reflective polarizing film of 3M turned out to have especially good reflective properties as compared with the embodiment comprising a thin metal film layer.

25 It will be clear to those skilled in the art that the invention is not limited to the embodiments described with reference to the drawing but may comprise all kinds of variations thereof. These and other variations are deemed to fall within the scope of protection of the appended claims.

## CLAIMS:

1. An electronic display device comprising:
  - a polymer LED display comprising a geometrical arrangement of individually excitable polymer LEDs for forming an image and comprising electrical connections for exciting said polymer LEDs; and
  - 5 - a light-absorbing filter layer covering said display;the display device further comprising:
  - a semi-transparent reflective layer covering said filter layer for transmitting light emanating from said polymer LED display and for reflecting ambient light incident on said semi-transparent reflective layer, so as to obscure said electrical connections for exciting
  - 10 said polymer LEDs.
2. An electronic display device as claimed in claim 1, characterized in that said semi-transparent reflective layer is a reflective polarizing layer.
- 15 3. An electronic display device as claimed in any one of the preceding claims, characterized in that said polymer LED display, said light-absorbing filter, and/or said semi-transparent reflective layer are coupled via an anti-reflective coating.
4. An electronic display device as claimed in any one of the preceding claims,
- 20 characterized in that the semi-transparent reflective layer is a brightness-enhancing layer manufactured by 3M Company of St. Paul, Minnesota under the trade designation "DUAL BRIGHTNESS ENHANCEMENT FILM".
5. An electronic appliance comprising an electronic display as claimed in any
- 25 one of the preceding claims.
6. An electronic appliance as claimed in claim 5, characterized in that it comprises an electric shaver.

1/2

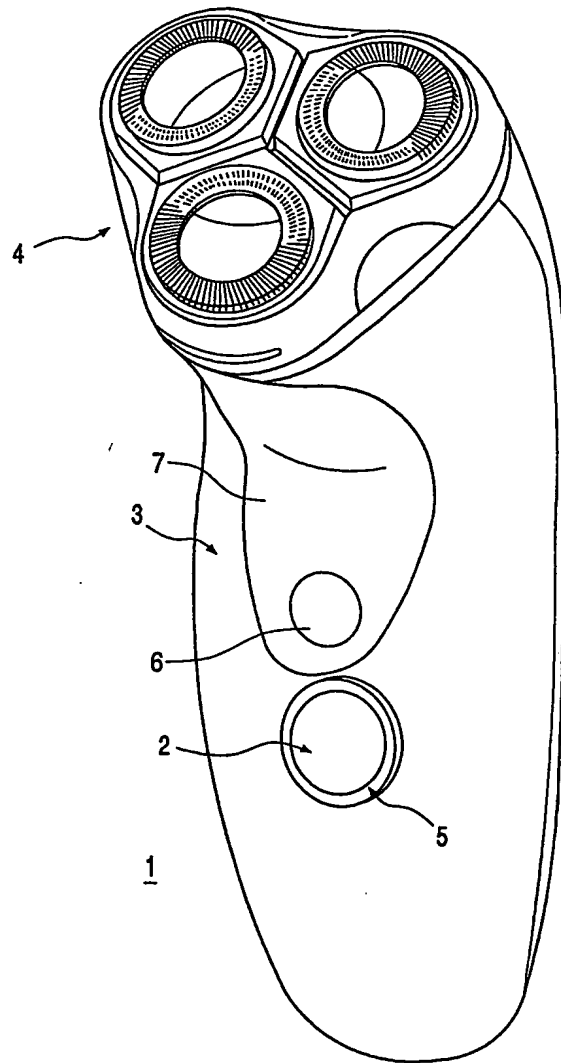


FIG. 1

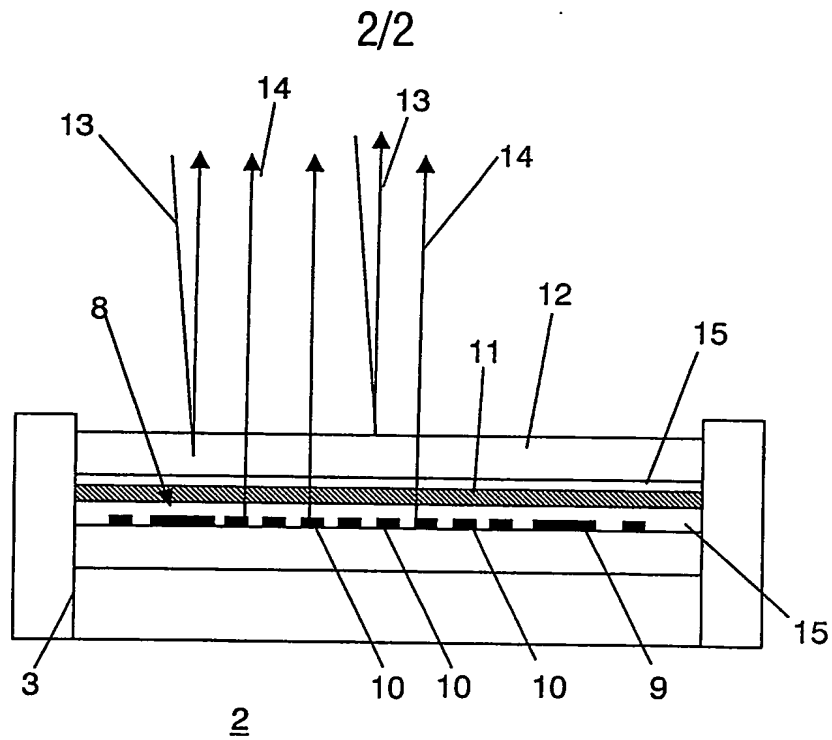


FIG.2

	Light Emission of Polymer LED	Mirror Effect
Polymer LED having first semi- transparent reflective layer	41%	47%
Polymer LED having 3M-DBEF semi-transparent reflective layer	59%	56%

FIG.3